Cadence Tips & Tricks

ALICIA KLINEFELTER

ECE 3663, SPRING 2013

Outline

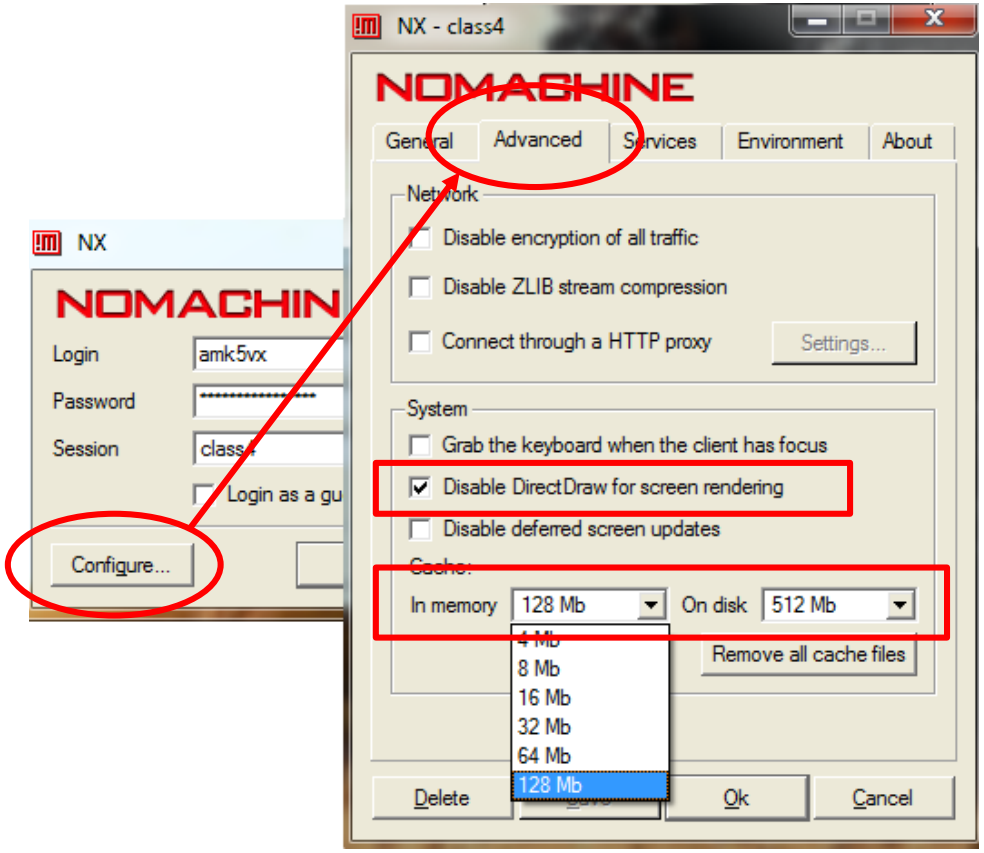
1. Using NXClient for Cadence
2. Cadence Setup
3. Schematic Labels
4. Exporting plots for presentations/papers/homework
5. Presenting schematics
6. Using Open Command Environment for Analysis (OCEAN) for simulation
7. Monte Carlo simulations (MCS) in FreePDK

Using NX Client from Home

Schematic viewer (Virtuoso) is incredibly slow from home.

Use the following NXClient settings from home to speed up your work.

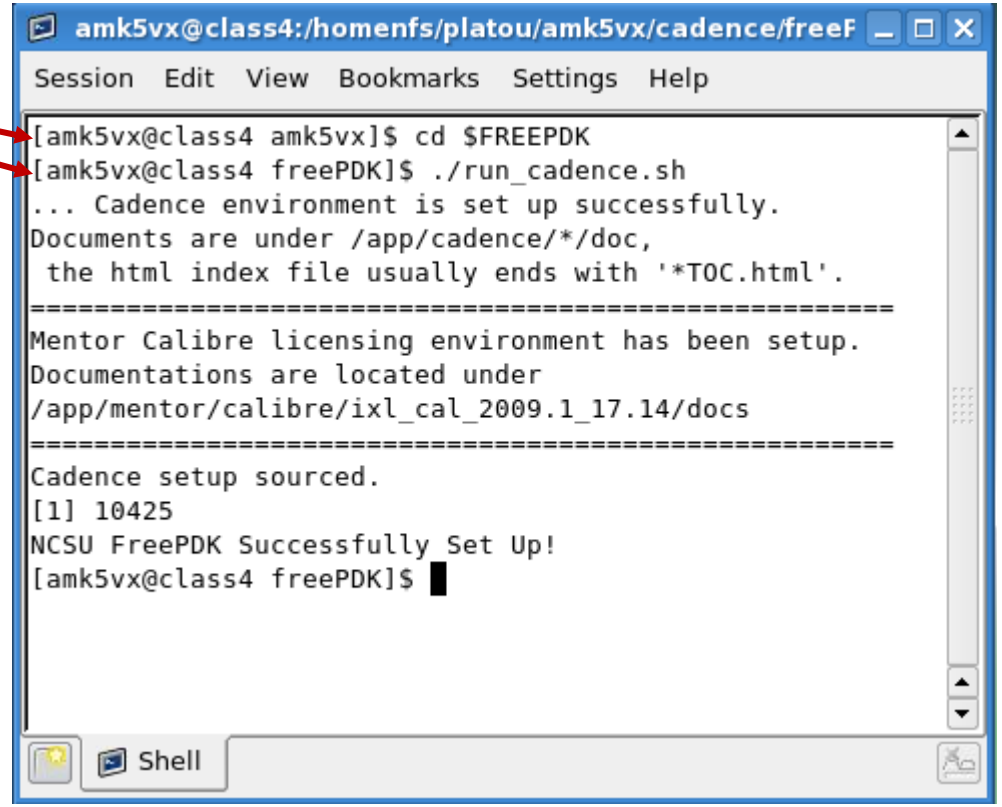
- Under the advanced tab
  - Select “Disable DirectDraw for screen rendering”
  - Under “Cache” max out both dropdowns



max out cache

Helpful Cadence Setup

Set up Cadence in two commands



Set environment variables in *~/.bashrc* file to jump to Cadence run directory:

- `export FREEPDK=/homenfs/platou/<userID>/cadence/freePDK/`

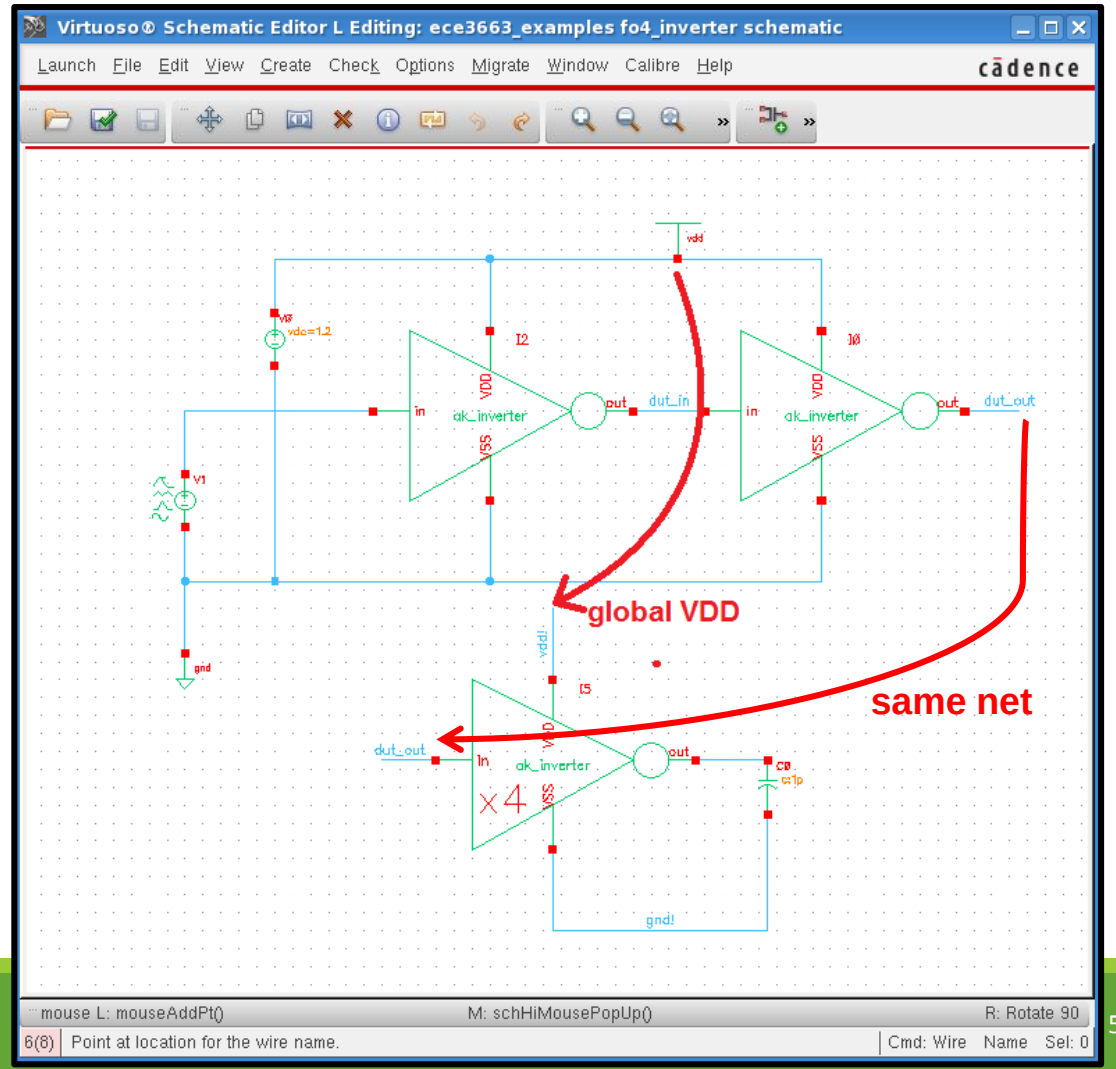
Use bash script to run all setup commands

- Script provided on Wiki

Adding Schematic Labels

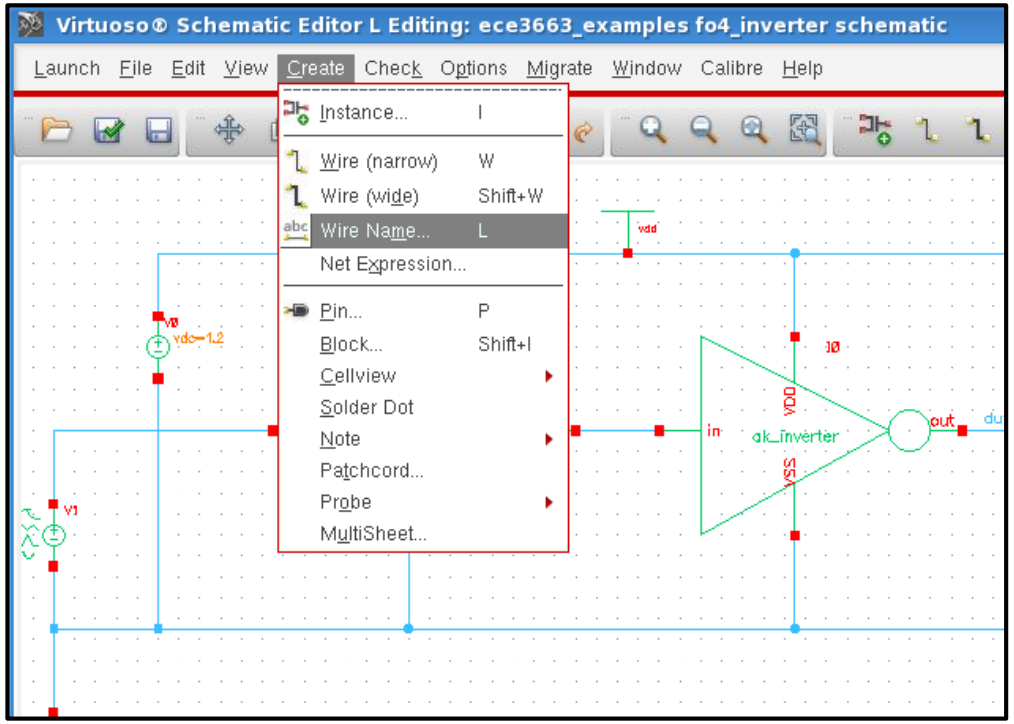
Schematic labels help in many scenarios

- Visual complexity of design (too many wires!)
- Automatic names for plotted signals
  - No “/net3” voltage signals in plots
- Act as documentation

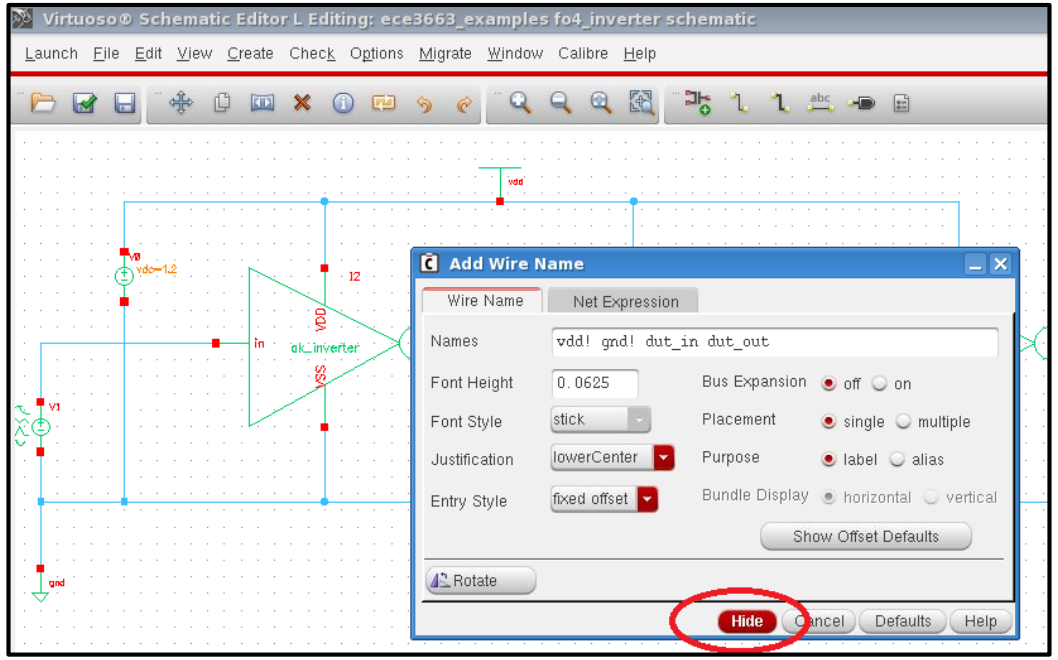


How To Add Schematic Labels

1. CREATE → WIRE NAME…
   - **Hotkey: L**



2. ADD MULTIPLE NET NAMES (SPACE DELIMITED)
   - **“Hide” and then select nets to drop label names**



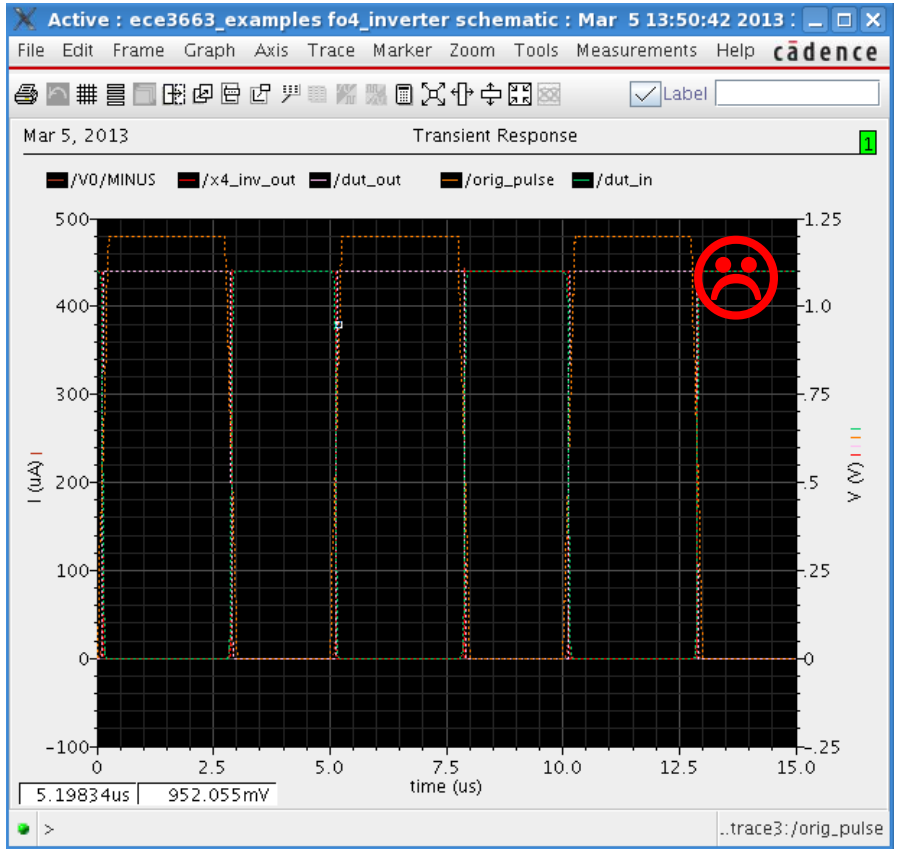
Exporting Plots

Black plot backgrounds are not ideal

- Plots will be difficult to see in presentations
- You will hemorrhage through your black ink cartridge printing out one homework

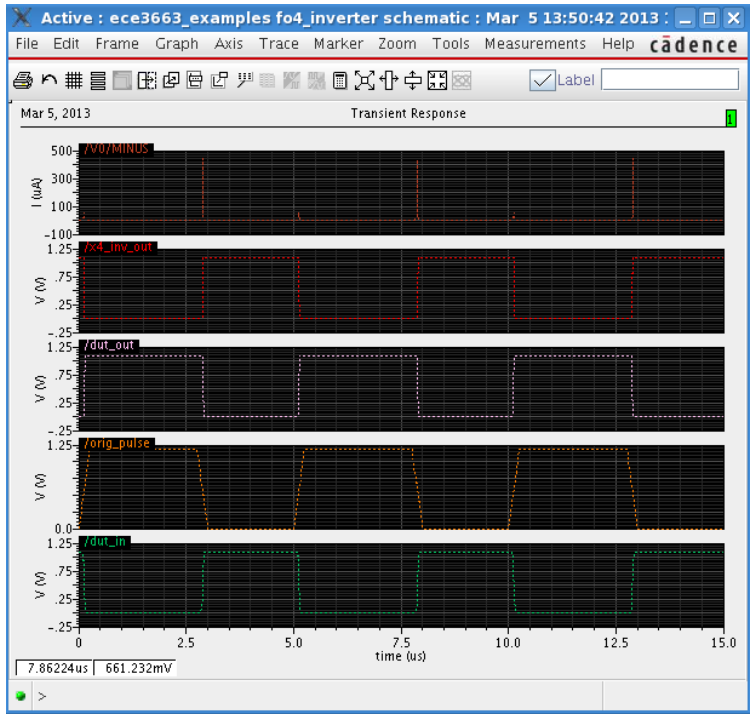
Options

- Modify plots in Cadence
- Export data, plot within MATLAB/Python/Excel/etc.
- Screenshots are technically an option, but it's not the best practice

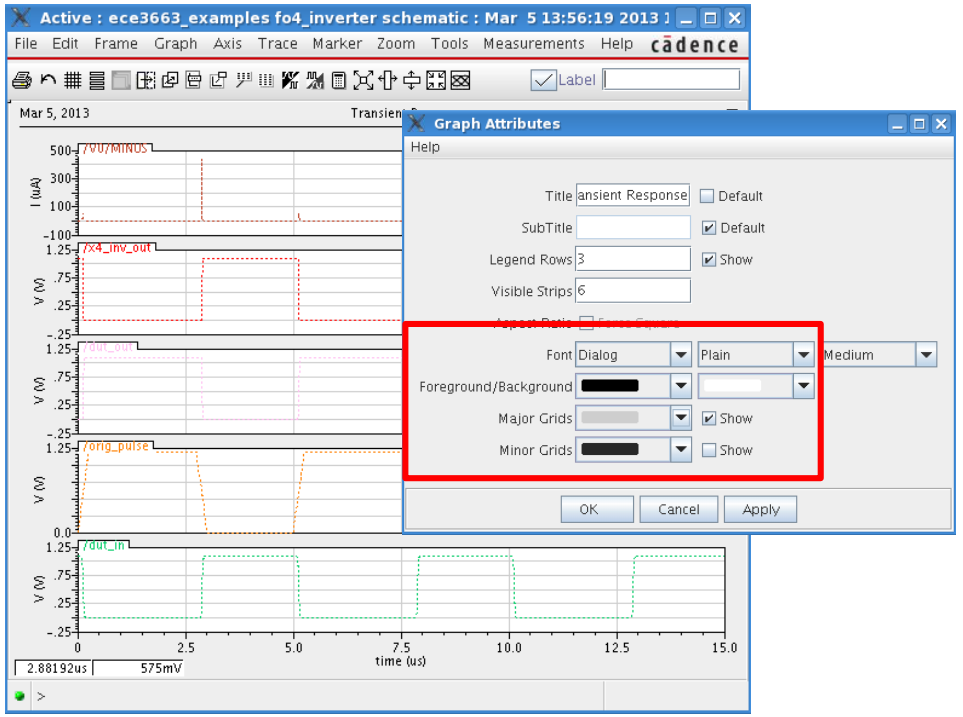


Modify Plots in Cadence

1. AXIS → STRIPS

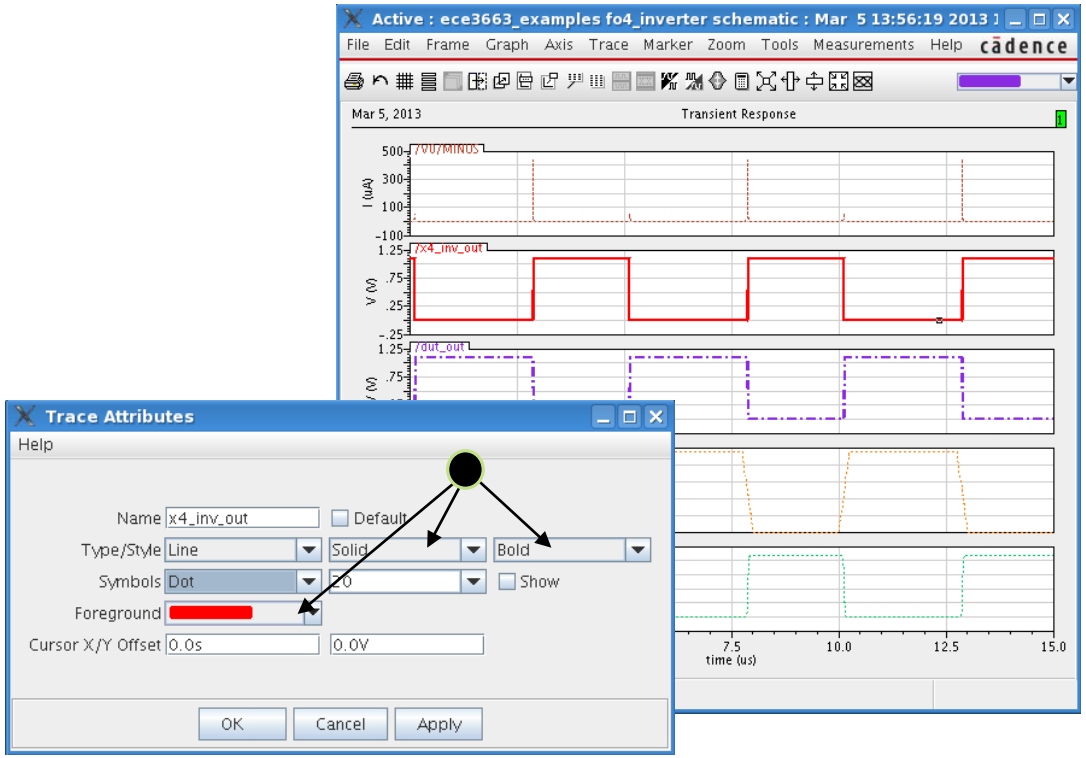


2. GRAPH → EDIT…
   - **To modify color scheme**
   - **This is a visual/optional step, to get trace color correct**

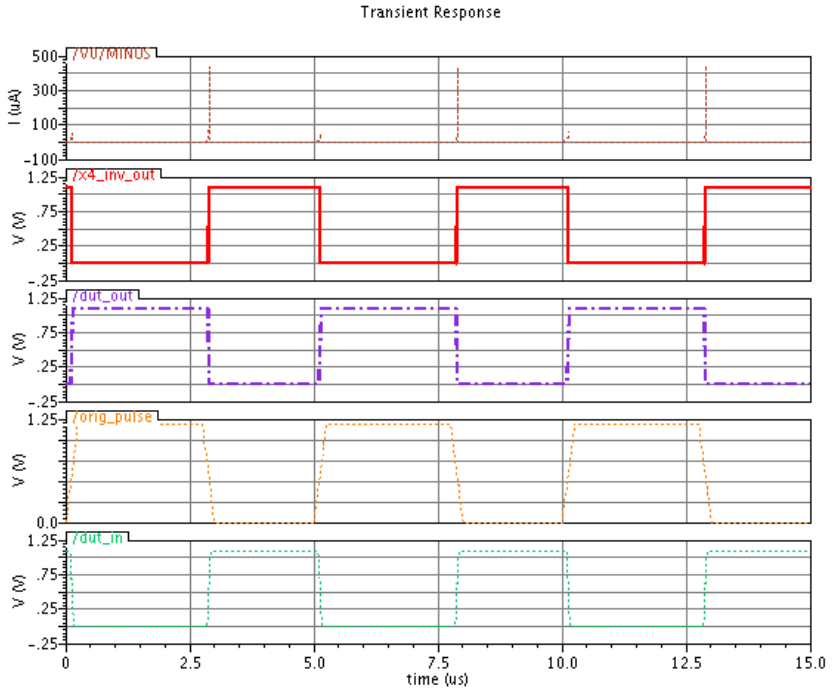


Modify Plots in Cadence

1. DOUBLE CLICK ON TRACES

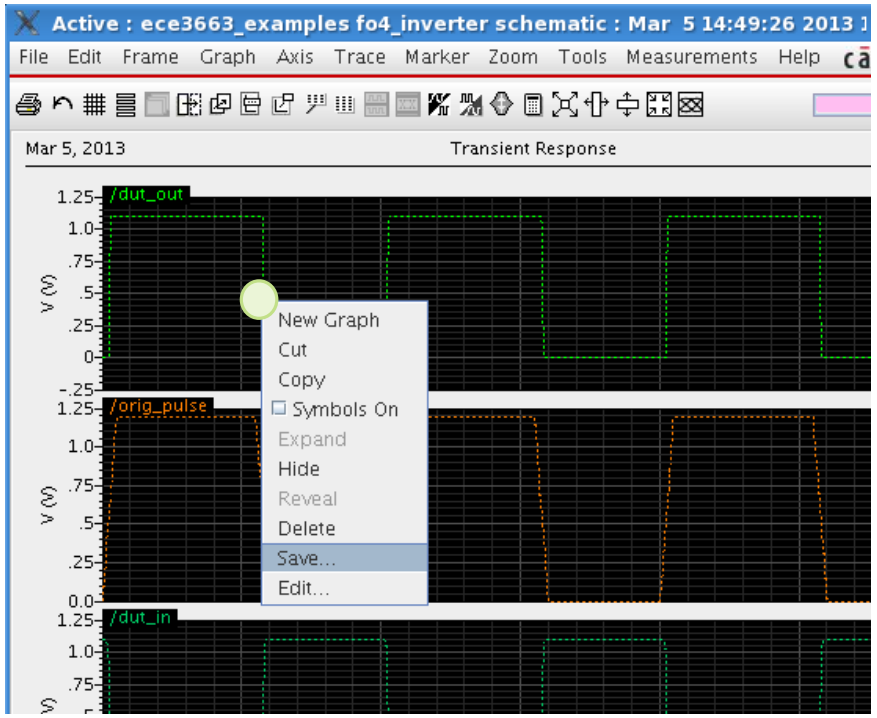


2. FILE → SAVE AS IMAGE…
   - **Check box for "Use white background"!**

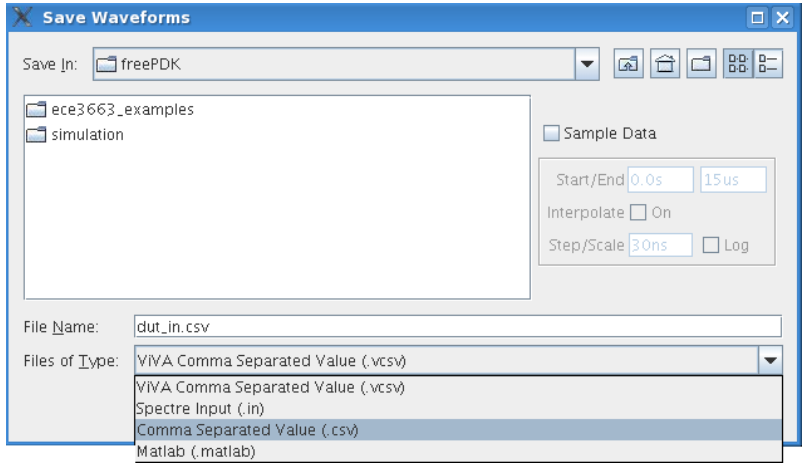


Export Plot Data

1. RIGHT-CLICK ON TRACE → SAVE



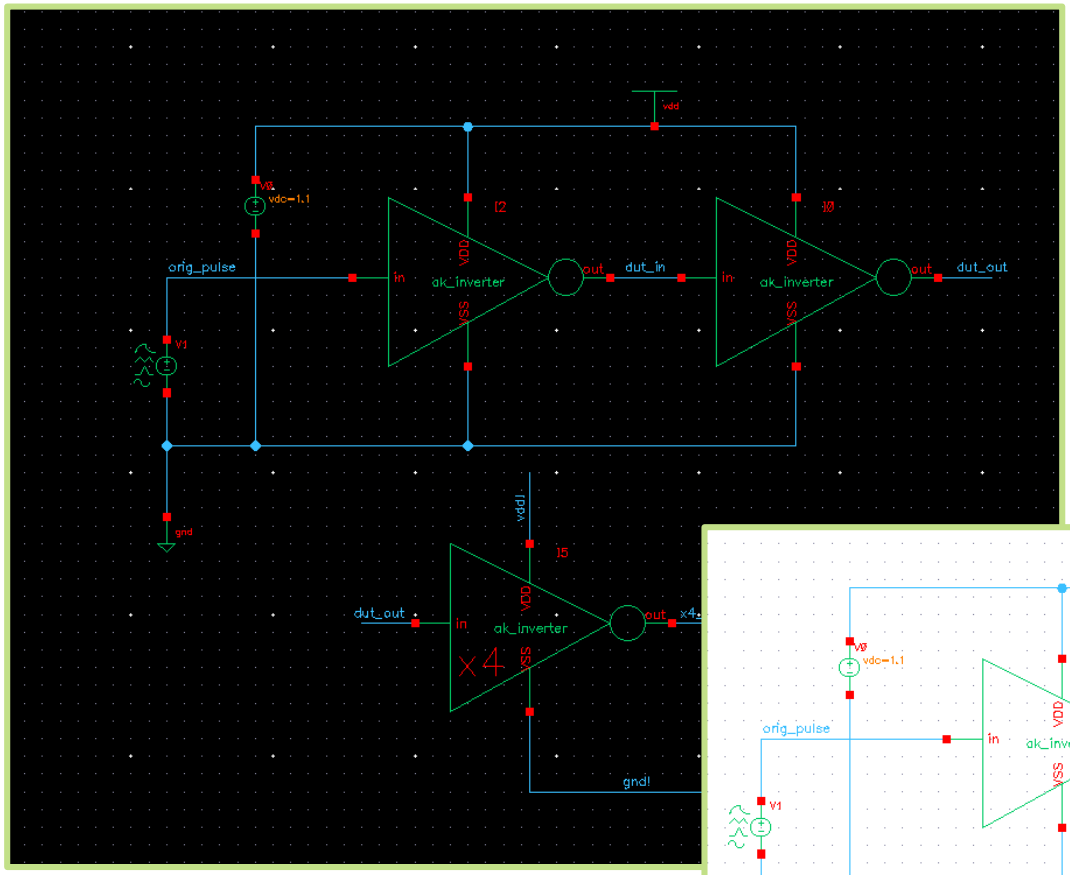
2. CAN EXPORT TO CSV, MATLAB FORMATS

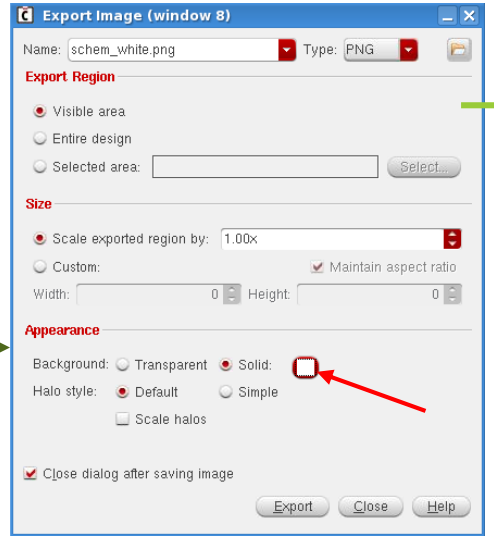


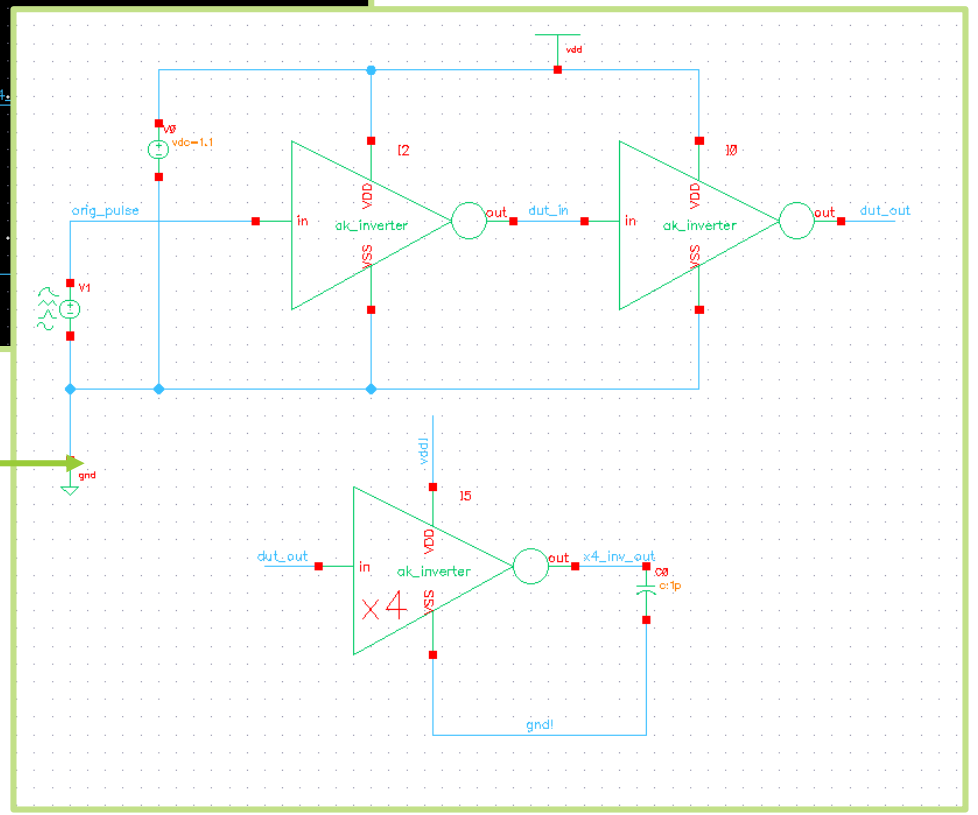
White Background for Schematics

- Black schematic backgrounds are not a good idea
  - Presentation visibility
  - Printing many of these will be bad for ink
    - Depending on the printer, it may not even show up
  - Example schematic to the right is bad, but it gets worse with complicated designs

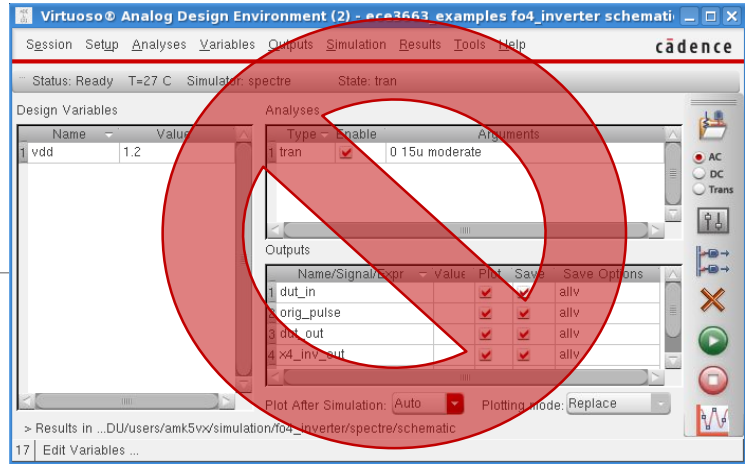
- From schematic viewer window: *File → Export Image*







OCEAN for Simulations



Lets you setup, simulate, and analyze circuit data

- Simulation programming language
- Good for repetitive tasks
- Built-in calculator
- Run longer analyses such as parametric analyses, Corners Analyses, and statistical analyses more effectively
- Run simulations from a non-graphic, remote terminal

OCEAN tutorial on Wiki

- venividiwiki.ee.virginia.edu/mediawiki/index.php/ToolsCadenceTutorialsBasicSimulationOceanFreePDK

OCEAN documentation on server

- /net/plato.ee.virginia.edu/app/cadence/ic/doc/oceanref
- Google-ing for OCEAN help isn't helpful

Getting Example OCEAN Script

- Making script from scratch is annoying
- Use ADE to create one
  - Within ADE: *Session → Save Ocean Script…*
  - Exports your current simulation settings

```
simulator( 'spectre )

design(       "/net/plato.ee.Virginia.EDU/users/amk5vx/simulation/fo4_inverter/spectre/schematic/netlist/netlist")

resultsDir( "/net/plato.ee.Virginia.EDU/users/amk5vx/simulation/fo4_inverter/spectre/schematic" )

modelFile(
    '("/net/plato.ee.virginia.edu/app/lib/freepdk45/trunk/ncsu_basekit/models/hspice/tran_models/models_nom/NMOS_VTL.inc" "")
    '("/net/plato.ee.virginia.edu/app/lib/freepdk45/trunk/ncsu_basekit/models/hspice/tran_models/models_nom/PMOS_VTL.inc" "")
    '("/net/plato.ee.virginia.edu/app/lib/freepdk45/trunk/ncsu_basekit/models/hspice/tran_models/models_nom/NMOS_VTG.inc" "")
    '("/net/plato.ee.virginia.edu/app/lib/freepdk45/trunk/ncsu_basekit/models/hspice/tran_models/models_nom/PMOS_VTG.inc" "")
)

analysis('tran ?stop "15u"  ?errpreset "moderate"  )
desVar(         "vdd" 1.2    )
save( 'v "/dut_in" "/orig_pulse" "/dut_out" "/x4_inv_out" )
save( 'i "/V0/MINUS" )
temp( 27 )
run()

selectResult( 'tran )
plot(getData("/dut_in") getData("/orig_pulse") getData("/dut_out") getData("/x4_inv_out") getData("/V0/MINUS") )
```

Useful OCEAN Functions

Looping structures
- foreach()
- while()

Conditionals
- if()
- case()

```
VDDLIST = list(0.3 0.4 0.5 0.6 0.7 0.8)
foreach( VDD VDDLIST
of = outfile("~/Results/fo4_inv/output.txt" "a")
desVar( "vdd" VDD      )
vdd = VDD
option( 'dochecklimit  "no"
)
```

Setting variables to use in the netlist

```
;; Length of all devices in circuit
desVar(   "length" 50n )
;; Width of the n/p devices
desVar(   "n_width" 90n )
desVar(   "p_width" 180n )
length=50n
n_width=90n
p_width=180n
```

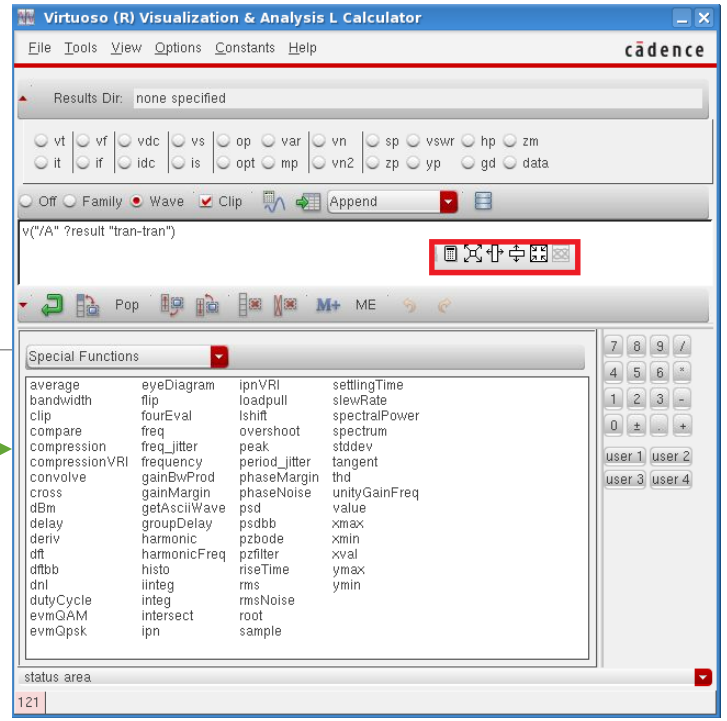
```
subckt INVX16TS A VDD VSS Y
NMOS (Y A VSS VSS) NMOS_VTH w=16*n_width l=length
PMOS (VDD A Y VDD) PMOS_VTH w=16*p_width l=length
ends INVX16TS
```

Useful OCEAN Functions

File I/O
- Formatting similar to C

Calculator functions
- Same syntax

Plotting




```
of = outfile("~/Results/fo4_inv/output.txt" "a")
fprintf( of "VDD(V)  Delay(s)\n")

<RUN ANALYSIS>

diff = abs((cross(v("in") vdd/2 1 "either" nil nil) - cross(v("out") vdd/2 1 "either" nil nil)))
plot( diff ?expr '( "diff" ) )
fprintf( of "%g      %g\n", vdd, diff)
close(of)
```

Running the Script

- For circuit simulations, create directory with:
  1. OCEAN script
  2. Stimuli file (if applicable)
  3. Circuit netlist
  4. Netlist footer
  5. Netlist header
- If simulation was run in ADE, the *netlist* and *_graphical_stimuli.scs* file are located:
  - /simulation/<design name>/spectre/schematic/netlist/

```
[amk5vx@class4 mc_test]$ . cadence2011

... Cadence environment is set up.

Documents are under /app/cadence/*/doc, the html index
file usually ends with '*TOC.html'.

[amk5vx@class4 mc_test]$ ocean

…

ocean> load "ocnScript.ocn"
```

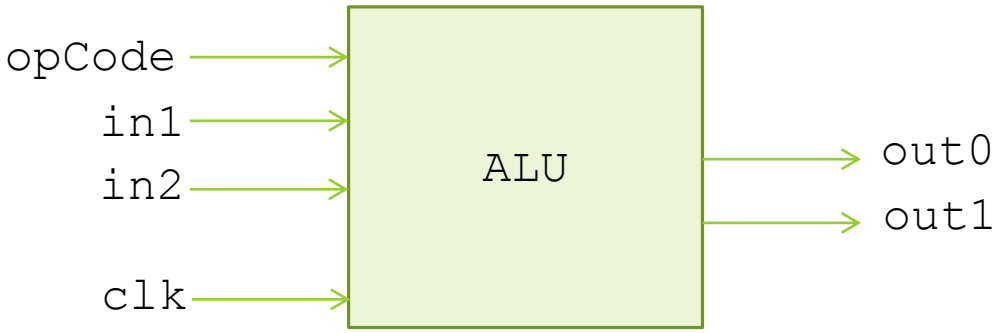
OCEAN for Max Frequency

Requires iteration, binary search

- Tedious to do in ADE with high granularity

Pseudo-code assuming the output value is known?

- `for {all frequencies in range}`
  1. `Run transient simulation at frequency x`
  2. `Check output values`
  3. `If they are correct, circuit success!`
  4. `Else, the circuit failed at this frequency. Fail!`
  5. `Print to the console the last successful frequency`



Express this in OCEAN syntax!

- Start iterating lowest frequency first
  - Check for existence before doing math: if (t1 && t2 && t3)
    - OCEAN errors out when doing math on “nil” data type

OCEAN for Power Determination

Many methods for computing circuit power

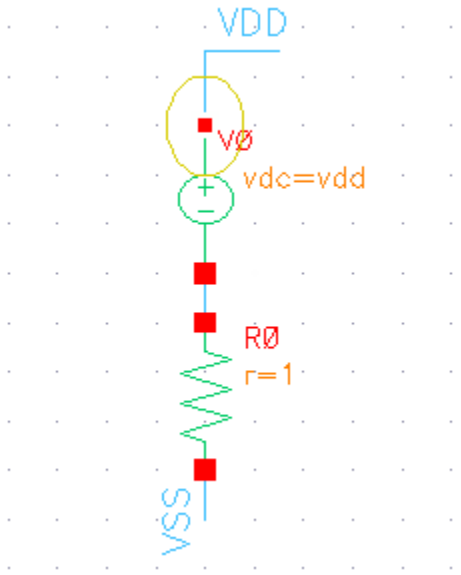
- p_{avg}=(i_{avg} over 1 clock period)*v

Measuring current can be tricky

- Many transistor symbols wont let you measure current using their terminals
- You can put in a “dummy” voltage source (0V) for measurement
  - All components found in the library *analogLib*

Determining power across frequencies

- Can use Cadence calculator, but tedious for so many frequencies
- How can you incorporate this into your OCEAN script?



measuring current

Monte Carlo Simulation

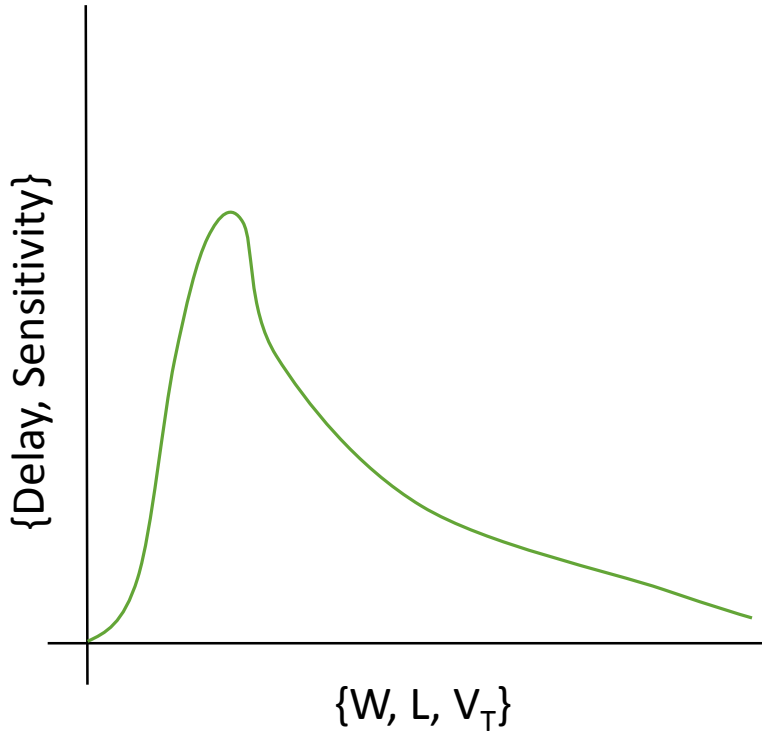
Transistor properties vary from wafer to wafer

- Process variations (V_T)
- Lithography (W, L, wire width)

Transistor model parameters are *averages*

- Parameters are more distributed in silicon

Monte Carlo simulates circuit over range of values for device parameters



Monte Carlo Simulation

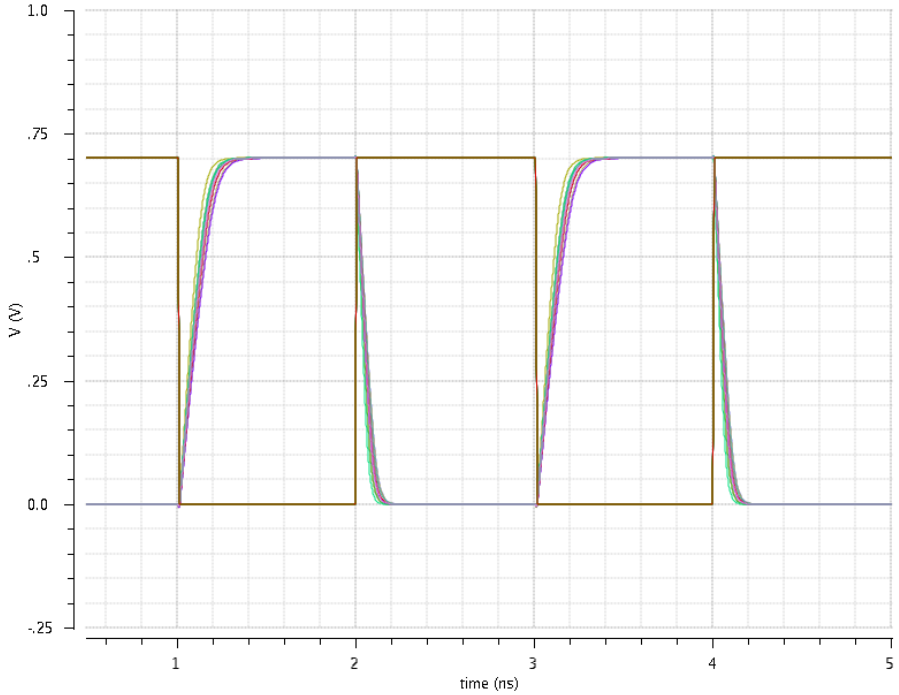
```
;; Now we need to define the models for the transistors
;; Here we hardcode the path to the model library
;; DEFINE THE MODEL
libdir = "./freepdk.scs" ; LIBRARY PATH

;; Set parameters specific to this model library to select the right model
deviceOption = "lvt"
Corner = "SS" ;  "TT" "FS" "FF" "SF" "SS" = THE GLOBAL CORNER CASES


…
;; RUN THE SIMULATION
monteCarlo( ?numIters 10 ?analysisVariation 'processAndMismatch ?sweptParam "None" ?sweptParamVals "25" ?saveData t )

;; MONTE CARLO EXPRESSION FOR MEASUREMENTS (Remember to put the monteexpr's BEFORE the monterun.
;; Or else the expression values would not get printed in the mcdata file)
monteExpr( "rt" "riseTime(v(\"out\" ?result 'tran) 0.5n t 1.5n t 10 90)" )
monteExpr( "ft" "riseTime(v(\"out\" ?result 'tran) 1.5n t 2.5n t 10 90)" )

;; START MONTE CARLO SIMULATION
save( 'all )
resultsDir("mcPSF")
monteRun()
…
```



Provided Files and Descriptions

For running Cadence using the bash script:

- run_cadence.sh

Example OCEAN scripts:

- monteCarlo.ocn / netlist